NISTTech

Polyelectrolyte Derivatization of Microfluidic Devices

Control microchannel fluid flow direction in a microfluidic device

Description

Typically for silica- and silicon-based devices, the most common methods for sealing the lid over the microchannels include high-temperature annealing, anodic bonding and wafer bonding depending on the substrate material. However, these techniques of microchannel fabrication and sealing are often difficult and/or expensive to implement. Although polymers, such as plastics, have been proposed as a possible alternative substrate for the fabrication of microfluidic devices, there still remains one large problem. Plastic surface chemical functionalities are not well characterized when compared to glass or silicon substrate. One such functionality is surface charge and surface density. These factors are significant for electroosmotic flow (EOF) to occur, which is commonly used to move fluids through microchannels. The direction and flow rate of EOF is determined by the charge and charge density respectively. Additionally, many common polymeric surfaces are either uncharged and extremely hydrophobic or negatively charged.

The present invention is able to overcome these difficulties by utilizing polyelectrolyte multilayers (PEM) to alter the surface of the microchannels fabricated in polymer-based substrates (either plastics or pure polymers). The PEM can be used to control the direction of flow of a fluid through the microchannels in a microfluidic device. Additionally, the invention can alter the charge on the surfaces of a microchannel. Thus, it can be used to control the direction in which an EOF fluid moves in a microchannel of a microfluidic device. Finally, the device provides a microchannel that allows flow of a fluid in opposite directions in the same microchannel.

Images

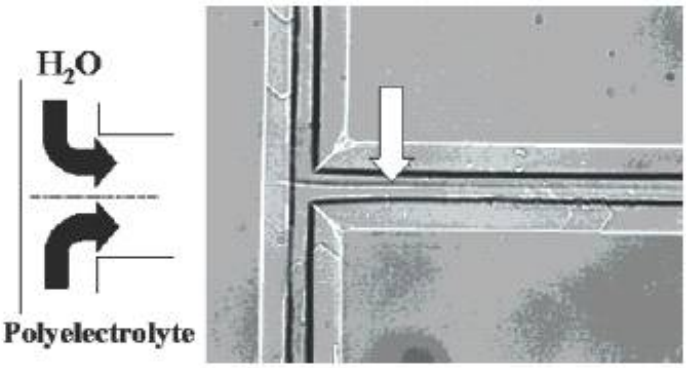

Figure 1. Laminar flow in a "T" chip used to selectively deposit the final polyelectrolyte layer in a single half of the channel. The contrast bisecting the channel-long axis, indicated by the white arrow, is due to the difference in the refractive indices of the water and the polyelectrolyte solution.

Image showing laminar flow in a "T" chip. Click for more information.

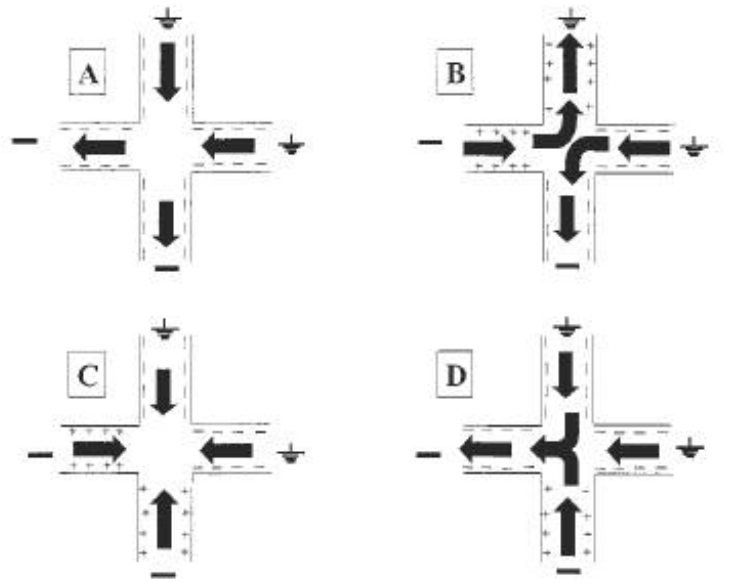

Figure 2. Four flow patterns achieved in cross-devices derivatized to have differing surfaces charges on the various arms. The applied voltages are the same in all cases.

Image showing various flow patterns. Click for more information.

Applications

- **Plastic microfluidics**
  Replaces expensive and difficult sealing processes used in the fabrication process with polyelectrolyte multilayers that control the direction of flow and alter the charge of surfaces.

Advantages

- **Simpler process**
  Replaces high-temperature annealing, anodic bonding and wafer bonding in microfluidic devices by using polymers.

Abstract

A microchannel device is provided with a plastic substrate having a microchannel formed therein. Polyelectrolyte multilayers are disposed along selected surfaces of the microchannel. The polyelectrolyte layers comprise alternating net positively charged layers and net negatively charged layers. A microchannel lid has a surface facing the microchannel. In making the microchannel device, selected surfaces of the microchannel are alternatively exposed to solutions comprising positively charged polyelectrolytes and negatively charged polyelectrolytes to form the desired number of polyelectrolyte layers.

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Related Items

- Article: Neuronal Cell Cultures Kept on the Straight and Narrow
- PowerPoint: Control and Modulation of Biochemical Reactions in Plastic Microfluid Devices
- PowerPoint: Derivatization of Plastic Microfluidic Devices with Polyelectrolyte Multilayers
- PowerPoint Presentation: Methods for Polymer Microfluidic Fabrication
- Plastic Microfluidic Devices Modified with Polyelectrolyte Multilayers
- Control of Flow Direction in Microfluidics Devices with Polyelectrolyte Multilayers
- Fabrication, Derivatization and Applications of Plastic Microfluidic Devices
- Control of Electroosmotic Flow in Laser-Ablated and Chemically Modified Hot Imprinted PETG Microchannels

References

- US Patent issued 03-01-2005
- Docket: 00-031US

Status of Availability

Patent active; available for licensing

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